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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
JONES, HUGH M	
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/542,490	Applicant(s) NOETINGER ET AL.	
	Examiner Hugh Jones	Art Unit 2128	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 09 July 2007.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1,2,4 and 5 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1, 2, 4, 5 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 09 July 2007 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Introduction

1. Claims 1-2, 4-5 of U.S. Application 10/542,490, filed 7/15/2005, are pending.

Claim Rejections - 35 USC § 101

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3. Claims 1-2 are rejected under 35 U.S.C. 101 as being directed to nonstatutory subject matter since the claims as a whole are drawn to an abstract mathematical algorithm and do not provide for a practical application, as evidenced by lack of physical transformation or a useful, tangible, and concrete result:

- claims 1-2 do not provide for a concrete, useful result;
- claims 1-2 do not provide for a tangible result.

4. Claims 4-5 are statutory because provide for a practical application, namely results which could be used in an actual injection.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

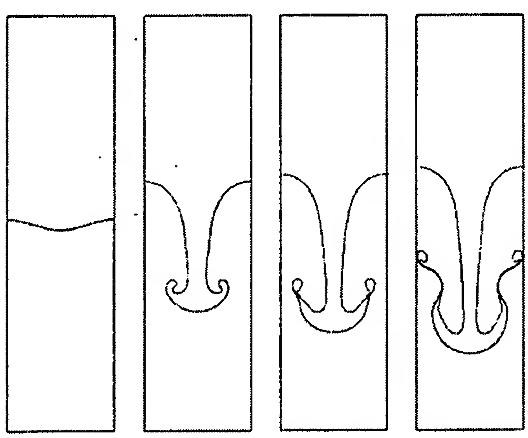
> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 1-2, 4-5 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

7. The limitations at issue include:

- considering an a priori interface form, assuming that the fluid displacements at any point thereof are stationary,
- determining the pressure field on either side of the a priori interface,
- iteratively changing the form of the interface until the pressures on either side of at least part of the interface become equal at any point of this part and
- assigning mean hydrodynamic properties uniformly to each zone of the medium delimited by each interface part, when said equalization is reached.

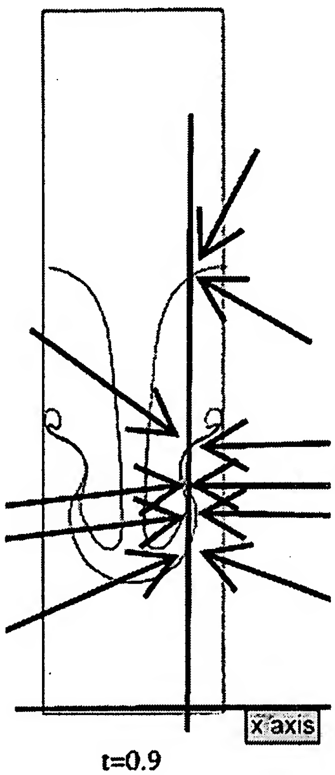
8. The first three limitations were not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Consider the following *realistic* example of an interface (fig. 9 of Popinet et al.):

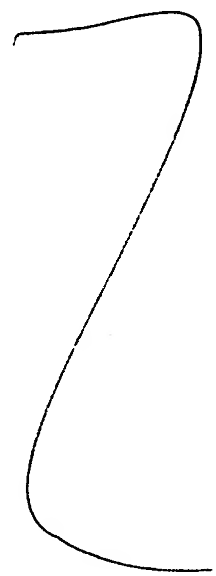


t=0.0 t=0.7 t=0.8 t=0.9

Figure 9. Rayleigh–Taylor instability on a 64 × 256 grid using the front-tracking algorithm.

Assume for the sake of argument that the interface corresponding to t=0.9 is taken to be the a priori interface. The interface for t=0.9 is reproduced; this time with arrows indicating all interfaces for a selected point (on the x axis):





9. Note, for this example, that there are five interfaces. The specification does not address such situations. The specification does not teach how to:

- provide for the *a priori* interface for any but the simplest situations (for example, what if the interface corresponding to t=0.9 is taken to be the a priori interface?);
- determine pressures on both sides of the *a priori* interface (the standard pressure equation) for any but the simplest cases;
- iteratively change the form of the interface until pressure equalization occurs for any but the simplest cases;

- set a "zone" for complex geometries (or any interface). In the situation in the above figure, the concept of "zone" appears to lose meaning.

10. The specification does not disclose whether stationary pressure equalization will actually occur, due to Rayleigh-Taylor instabilities. It also appears that if the initial interface is stationary, that the pressure would already be inherently equalized.

11. It is not clear how to iteratively change the form of the interface until the pressures on either side of at least _part of the interface becomes equal_ at any point of this part. If the interface is an inclined plane, then how is it possible for the pressure to be equal at any point of a part of the interface? (consider gravity) Furthermore, for example, if there are two zones, is it possible to have pressure equalization between the interfaces within each of the two zones without the interfaces matching up (_what if there is a source in one zone and a sink in another zone_)?

12. The claims repeatedly refer to pressures on *either* side of the interface becoming equal at any point of a part of the interface. If the stationary solution for the interface is an inclined plane, then how is it possible for the pressure to be equal at any point of a part of the interface? (consider gravity) Furthermore, the claim as recited raises the question of whether pressures on *both* sides of the interface are required to be equal to each other.

Claim Rejections - 35 USC § 102

13. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

14. A person shall be entitled to a patent unless –

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

15. Claims 1-2 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Popinet et al. (**P**). Specifics provided subsequent to the 103 rejections.

16. Claims 1-2, 4-5 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Karksen et al. (**K**). Specifics provided subsequent to the 103 rejections.

Claim Rejections - 35 USC § 103

17. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

18. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

19. Claims 4-5 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Popinet et al. in view of Karlsen et al. and Sheldon et al. (of record).

20. Popinet teaches front tracking and iterative simulation, but does not expressly disclose using the front simulation method for studies of injected liquids in reservoirs.

21. Karlsen discloses such an application.

22. It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the base reference with the Karlsen teaching because Sheldon discloses that the solution of moving interface problems is important in predicting the behavior of oil reservoirs under various conditions of production (first sentence, introduction).

23. Specifically the art discloses:

1) A method for determining, in a stratified medium whose physical properties are known or estimated, at least one zone where an interface between a fluid in place in the medium and a flushing fluid, of known different viscosities and densities, injected in the medium, moves in a stationary manner, in order to simplify construction of a model simulating the flows in the medium, characterized in that it comprises the following
- considering an a priori interface form, assuming that the fluid displacements at any point thereof are stationary *(P: section 3 [front tracking algorithm]; sections 3.1-3.2; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*,
- determining the pressure field on either side of the a priori interface *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction];; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*,
- iteratively changing the form of the interface until the pressures on either side of at least part of the interface become equal at any point of this part *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])* and
- assigning mean hydrodynamic properties uniformly to each zone of the medium delimited by each interface part, when said equalization is reached *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction];; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*.
- determining the form of least one zone of the medium delimited by a stationary displacement interface, which corresponds to different values of the flushing fluids viscosity *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure*

gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26]), and
- selecting the viscosity of the flushing fluid for which the stationary displacements in said medium are optimized. *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26]).*

2) A method as claimed in claim 1, characterized in that, for lack of obtaining a pressure equalization on either side of the interface along the latter, the interface is segmented into several parts and the form of these different parts is modified iteratively and separately, until a pressure equalization is obtained on either side thereof, the extent of each interface part when said equalization is reached, delimiting a favorable zone to which mean hydrodynamic properties are uniformly assigned *(P: section 3 [front tracking algorithm]; the simulation is done on cells in a grid; "piecewise linear interface calculation (PLIC:VOF) code" [pg. 785]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26]).*

4. A method for optimizing the recovery of a hydrocarbon fluid in place in a stratified hydrocarbon reservoir, comprising constructing a reservoir model of the stratified hydrocarbon reservoir, characterized in that it comprises the following stages:
a) selecting at least one layer of the stratified hydrocarbon reservoir where an interface between the fluid in place and a flushing fluid moves in a stationary manner, by:
- constructing an a priori interface form, assuming that the hydrocarbon fluid displacements at any point thereof are stationary*(P: section 3 [front tracking algorithm]; sections 3.1-3.2; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*,
- determining the pressures field on either side of the a priori interface *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction];; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*,
- iteratively changing the form of the interface until the pressures on either side of at least part of the interface become equal at any point of this part *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-*

wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26]),
b) modifying the said reservoir model by assigning mean hydrodynamic properties uniformly to each zone of the hydrocarbon reservoir delimited by each interface part, when said equalization is reached *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction];; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26];*
c) determining a viscosity of the flushing fluid which allows to optimize the recovery, by selecting the viscosity which optimize the stationary displacements in said hydrocarbon reservoir, by using the said model *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26]);* and
d) injecting a flushing fluid having said viscosity into the stratified hydrocarbon reservoir to drive the hydrocarbon fluid to be recovered (page 14, first full paragraph).

5. A method as claimed in claim 4, wherein, for lack of obtaining a pressure equalization on either side of the interface along the latter, the interface is segmented into several parts and the form of these different parts is modified iteratively and separately, until a pressure equalization is obtained on either side thereof, the extent of each interface part, when said equalization is reached, delimiting a favourable layer to which mean hydrodynamic properties are uniformly assigned*(P: section 3 [front tracking algorithm]; the simulation is done on cells in a grid; "piecewise linear interface calculation (PLIC:VOF) code" [pg. 785]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26].*

24. Note that Karlsen et al. teaches (pp. 5-6):

THE TWO-PHASE FLOW MODEL

We study immiscible flow of water and oil in a two-dimensional oil reservoir Ω over a time period $(0, T]$. To focus on the main ideas of the algorithm,

we consider a simplified prototype two-phase model[22], assume incompressible flow, and neglect gravity. If we choose the total Darcy velocity u, the global fluid pressure p, and the water saturation s as primary variables, the immiscible displacement of oil by water is governed by a (non-dimensional) system of nonlinear partial differential equations.

We have the pressure equation

$$-\nabla \cdot (K(\lambda_w + \lambda_o)\nabla p) = 0, \text{ in } \Omega \times (0,T], \quad (6)$$

where $K = K(x, y)$ denotes the absolute permeability tensor, $\lambda_i = k_{ri}/\mu_i$ are the mobilities, $k_{ri} = k_{ri}(s)$ the relative permeabilities, and μ_i the viscosities of water and oil, $i = w, o$, respectively.

The pressure equation is coupled via the total Darcy velocity $u = -K(\lambda_w + \lambda_o)\nabla p$ to the saturation equation

$$\phi\partial_t s + \nabla \cdot (uf) - \epsilon\nabla \cdot (D\nabla s) = 0, \text{ in } \Omega \times (0,T]. \quad (7)$$

Here $\phi = \phi(x, y)$ is the porosity of the rock in the reservoir. The fractional

Response to Arguments

25. Applicant's arguments, filed 7/9/2007, have been carefully considered and are not persuasive.

101 Rejections:

26. Applicant's arguments relating to the 101 rejections are not persuasive. The claims are directed to abstract mathematical ideas, and constitute little more than the application of mathematical equations, to abstract analysis of hypothetical fluid interfaces – hence *mathematical* and *abstract*. The rejections were applied in view of the court cases cited by Applicants. As noted by Applicants,

> U.S.C. 101. The Supreme Court has construed section 101 broadly, noting that Congress intended statutory subject matter to "include anything under the sun that is made by man." *Diamond v. Charkrabraty*, 447 US 303, 309 (1980). Despite this seemingly limitless expense, the Court has specifically identified three categories of unpatentable subject matter: laws of nature, natural phenomena and abstract ideas. *Diamond v. Diehr*, 450 US 175, 185

Applicants are attempting to patent abstract ideas, as noted in the rejection. Applicants argue:

> In the outstanding office action in this case, the Examiner alleges that "the claims as a whole are drawn to an abstract mathematical algorithm and do not provide a practical application, as evidenced by a lack of physical transformation or useful, tangible, and concrete result." However, the Examiner's reasoning is incorrect. While certain types of mathematical subject matter, standing alone, represent nothing more than abstract ideas until reduced to some type of practical application, i.e., a useful, concrete, and tangible result, a mathematical algorithm is unpatentable *only* to the extent that it represents an abstract idea. *State Street Bank & Trust v. Signature Financial Group*, 149 F.3d 1368, 47 USPQ 2d 1596, 1600-1601 (Fed. Cir. 1998), *cert. denied*, 525 U.S. 1093 (1999). Thus, unpatentable mathematical algorithms are identifiable by showing they are merely abstract ideas constituting disembodied concepts or truths that are not "useful." From a practical standpoint, this means that, to be patentable, an algorithm must be applied in a "useful" way. *State Street, supra*, 47 USPQ 2d at 1601. Here,
>
> the claimed method produces a useful, concrete and tangible result and therefore constitutes patentable subject matter.

27. Applicants have *not attempted to identify the <u>practical application</u>* and show that there is a physical transformation of matter *or* a concrete, useful tangible result. Applicants were provided ample notice of the deficiency. Applicants only allege:

> In the present case, the claimed method determines at least one zone where an interface between a fluid in place in the medium and a flushing fluid, of known different viscosities and densities, injected in the medium, moves in a stationary manner, in order to simplify construction of a model simulating the flows in the medium and, as presently claimed, selects the viscosity of the flushing fluid. It is clear that the selection of the viscosity of the flushing fluid is or corresponds to a useful, concrete and tangible result.

28. Claim 1 now recites:

1) (Currently Amended) A method for determining, in a stratified medium whose physical properties are known or estimated, at least one zone where an interface between a fluid in place in the medium and a flushing fluid, of known different viscosities and densities, injected in the medium, moves in a stationary manner, in order to simplify construction of a model simulating the flows in the medium, characterized in that it comprises the following stages:

- considering an *a priori* interface form, assuming that the fluid displacements at any point thereof are stationary,

- determining the pressure field on either side of the *a priori* interface,

- iteratively changing the form of the interface until the pressures on either side of at least part of the interface become equal at any point of this part, ~~and~~

- assigning mean hydrodynamic properties uniformly to each zone of the medium delimited by each interface part, when said equalization is reached,

- determining the form of at least one zone of the medium delimited by a stationary displacement interface, which corresponds to different values of the flushing fluids viscosity, and

- selecting the viscosity of the flushing fluid for which the stationary displacements in said medium are optimized.

29. It is noted that "for which the stationary displacements are *optimized*" is not useful. The specific and substantial utility is unknown. The claim is merely drawn to determining a class of mathematical solutions (stationary) to movement of an interface between two hypothetical fluids..

30. As Applicants are aware, to satisfy 35 U.S.C. 101, an invention must be "useful." See MPEP 2107.01:

> Deficiencies under the "useful invention" requirement of 35 U.S.C. 101 will arise in one of two forms. The first is where it is not apparent why the invention is "useful." This can occur when an applicant fails to identify any *specific and substantial utility* for the invention or fails to disclose enough information about the invention to make its usefulness immediately apparent to those familiar with the technological field of the invention. Brenner v. Manson, 383 U.S. 519, 148 USPQ 689 (1966); > In re

Fisher, 421 F.3d 1365, 76 USPQ2d 1225 (Fed. Cir. 2005);< In re Ziegler, 992 F.2d 1197, 26 USPQ2d 1600 (Fed. Cir. 1993).

...

A "specific utility" is *specific to the subject matter claimed* and can "provide a well-defined and particular benefit to the public." In re Fisher, 421 F.3d 1365, 1371, 76 USPQ2d 1225, 1230 (Fed. Cir. 2005). *This contrasts with a general utility that would be applicable to the broad class of the invention*. Office personnel should distinguish between situations where an applicant has disclosed a specific use for or application of the invention and situations where the applicant merely indicates that the invention may prove useful without identifying with specificity why it is considered useful.

31. Applicants have *not attempted to identify the practical application* and show that there is a physical transformation of matter or a concrete, useful tangible result.

32. Applicants allege:

> In the 101 rejection, the Examiner appears to require a physical transformation for the method to satisfy the "useful, concrete and tangible result" requirement. The Examiner's reliance on a physical transformation is misplaced since the tangible result requirement does not necessarily mean that a claim must either be tied to a particular machine or apparatus or must operate to change articles or materials to the different state or thing. *Manual of Patent Examining Procedure* (*MPEP*) §2106. See, also, *AT&T Corp., supra*, 50 USPQ 2d at 1452-53.

33. The rejection made *no such statement.* The rejection stated (emphasis added): "Claims 1-2, 4-5 are rejected under 35 U.S.C. 101 as being directed to nonstatutory subject matter since the claims as a whole are drawn to an abstract mathematical algorithm and do not provide for a practical application, as evidenced by lack of physical transformation ***or*** a useful, tangible, and concrete result".

34. In fact, Applicants acknowledge this fact (first full paragraph, page 7):

In the outstanding office action in this case, the Examiner alleges that "the claims as a whole are drawn to an abstract mathematical algorithm and do not provide a practical application, as evidenced by a lack of physical transformation or useful, tangible, and concrete result." However, the

35. Applicants have *not identified the practical application* and shown that there is a physical transformation of matter or a concrete, useful tangible result.

112 Rejections:

36. Applicants argue:

As pointed out on page 1, lines 5-7 of Applicants' specification, the present invention relates to a method for determining in a stratified porous medium (hydrocarbon reservoir) wherein the front or interface between fluids in place and flushing fluids moves in a stationary manner, i.e., without deformation and at constant velocity.

The example given by the Examiner in numbered sections 9 and 10 of the Office Action is not applicable to a stratified porous medium; it is only applicable to fluid directly in contact, such as a bubble (see Summary). The method of Popinet is dedicated to problems involving a moving interface in a multiphase fluid flow (see Introduction of Popinet). In this context, the motion of fluids is described by the Navier-Stokes equations. These are the used by Popinet. In the context of stratified porous medium, the motion of fluids is described by the Darcy equation.

The terms "porous" and "Darcy equation" are not recited in the claims. Regardless, *Karlsen*, for example, teaches (pp. 5-6):

THE TWO-PHASE FLOW MODEL

We study immiscible flow of water and oil in a two-dimensional oil reservoir Ω over a time period $(0, T]$. To focus on the main ideas of the algorithm,

we consider a simplified prototype two-phase model[22], assume incompressible flow, and neglect gravity. If we choose the total Darcy velocity u, the global fluid pressure p, and the water saturation s as primary variables, the immiscible displacement of oil by water is governed by a (non-dimensional) system of nonlinear partial differential equations.

We have the pressure equation

$$-\nabla \cdot (K(\lambda_w + \lambda_o)\nabla p) = 0, \text{ in } \Omega \times (0,T], \tag{6}$$

where $K = K(x,y)$ denotes the absolute permeability tensor, $\lambda_i = k_{ri}/\mu_i$ are the mobilities, $k_{ri} = k_{ri}(s)$ the relative permeabilities, and μ_i the viscosities of water and oil, $i = w, o$, respectively.

The pressure equation is coupled via the total Darcy velocity $u = -K(\lambda_w + \lambda_o)\nabla p$ to the saturation equation

$$\phi \partial_t s + \nabla \cdot (uf) - \varepsilon \nabla \cdot (D \nabla s) = 0, \text{ in } \Omega \times (0,T]. \tag{7}$$

Here $\phi = \phi(x,y)$ is the porosity of the rock in the reservoir. The fractional

37. Applicants argue:

> In addition, the figure chosen by the Examiner clearly indicates a deformation of the interface. This is in contradiction with the present invention, in which the interface between fluids in place and the flushing fluids moves in a stationary manner, i.e. without deformation and at constant velocity.
>
> One skilled in the art knows how to chose an *a priori* interface form in the claimed conditions i.e., a stratified porous medium and a front without deformation. The surface t=0.9 cannot correspond to a surface of a front in a stratified porous medium wherein the front or interface between fluids in place and flushing fluids moves in a stationary manner, i.e., without deformation and at constant velocity.

The front in Applicant's invention is "deformed" with respect to the final form of the front. The surface at t=0.9 was used to illustrate the issue. Consider a stationary vortex and complex fronts, such as those associated with sources and sinks in fluid flow. As noted

earlier, the term porous is not recited in the claims. Of course a vortex or other complex front may be stationary.

38. Applicants argue:

> In numbered section 11, the Examiner discusses Rayleigh-Taylor instabilities. If a dense viscous layer rests on top of a less dense viscous layer, the lower layer will become unstable and form a Rayleigh-Taylor instability. However, in the present application, as is well known to those skilled in the art, the interface is not sub-horizontal, but sub-vertical. Therefore, the Rayleigh-Taylor instabilities cannot occur in the context of enhance oil recovery in a porous reservoir.

The distinction is not reflected in the claims. Applicant's argument that a limitation relating to "What is well known" is in the claims is abstract.

39. Applicants argue:

> As to numbered section 12 of the Office Action, Applicants do not claim that the pressure is equal at any point of a part of the interface. What Applicants claim is "the pressures on either side of at least part of the interface become equal at any point of this part." Applicants equalize the pressure on the right and on the left of the interface. It is obvious there is a continuity of the pressure in the reservoir. The example taken by the

This is a contradictory statement. As noted by Applicants, "on either side" *is recited in the claim*; the claim does not require that the pressure be equal on *both* sides, *as argued*. Whether the missing element is *obvious* is not pertinent to whether it is inherent or *claimed*. The rejection is maintained.

40. Applicants argue:

> Examiner, (source and sink) is typically one of the applications; the pressure is greater on the side of the source. It decreases going towards the other zone. But it decreases continuously. So, at the interface, the pressure should be equal. If it is not possible to equalize these pressures, it means the conditions are not stationary (see page 13, lines 11 and 12, and claim 2).
>
> For the foregoing reasons, Applicants disclosure enables one skilled in the art to make and/or use the invention.

This is not accurate. Consider stationary Bernoulli flow in a pipe consisting of three sections, wherein the middle section has a different radius than the other two sections. A flow may be stationary in the absence of equalized pressures across an interface. A stationary process refers to a random process where all of its statistical properties _do not vary with time_. There is no restriction on the spatial properties. Thus, for example, a vortex may have a complex spatial distribution and still be stationary because its statistical properties (such as pressure) are invariant with respect to time at each spatial point.

41. The lines in question recite (lines 11-12):

> This minimization process may not converge. In this case, there is no stationary front over the total thickness of the medium. The method described therefore has to be

A converged *minimization* does not require *equalization.*

42. Applicants argue:

> Claims 1-3 stand rejected under 35 U.S.C. 112, second paragraph, as allegedly being incomplete for omitting essential steps. Applicants traverse this rejection and request reconsideration thereof.
>
> In support of the rejection under 35 U.S.C. 112, second paragraph, the Examiner alleges that the omitted steps are the specifics of the steps already recited in the claims. Since the steps are already recited, by definition they cannot be missing. While the steps are recited more broadly than disclosed in the specification, it is noted that the breadth of the claim is not to be equated with indefiniteness. *In re Miller*, 441 F.2d 689, 169, U.S.P.Q. 697 (CCPA 1971); *MPEP* 2173.04.

The rejection is withdrawn.

43. Applicants argue:

> Claims 1-3 stand rejected under 35 U.S.C. 102(b) as allegedly being clearly anticipated by Popinet et al. or Karlsen et al. Applicants traverse this rejection and request reconsideration thereof.
>
> The Popinet document is not pertinent as it does not concern the same technical domain as the present invention. The method described in Popinet
>
> cannot be applied in a porous medium such as a reservoir. Moreover, neither

44. "Arguments that the alleged anticipatory prior art is 'nonanalogous art' or 'teaches away from the invention' or is not recognized as solving the problem solved by the claimed invention, [are] ***not*** 'germane' to a rejection under section 102." *Twin Disc, Inc. v. United States*, 231 USPQ 417, 424 (Cl. Ct. 1986) (quoting *In re Self*, 671 F.2d 1344, 213 USPQ 1, 7 (CCPA 1982)). See also *State Contracting & Eng' g Corp. v. Condotte America, Inc.*, 346 F.3d 1057, 1068, 68 USPQ2d 1481, 1488 (Fed. Cir. 2003) (The question of whether a reference is analogous art is not relevant to whether that reference anticipates. A reference may be directed to an entirely different problem than

the one addressed by the inventor, or may be from an entirely different field of endeavor than that of the claimed invention, yet the reference is still anticipatory if it explicitly or inherently discloses every limitation recited in the claims.). See MPEP 2131.05.

45. Regardless, Applicants have provided neither actual rationale nor any evidence for the allegation that "The Popinet document is not pertinent as it does not concern the same technical domain" and "the method described in Popinet cannot be applied in a porous medium such as a reservoir".

46. Applicants further argue:

> cannot be applied in a porous medium such as a reservoir. Moreover, neither Karlsen nor Popinet describes a method wherein the form of the interface is determined iteratively according to pressure on either side of the interface. The front tracking method in Karlsen is described from page 22. Not one of the presently claimed steps is disclosed.

47. Respectfully, Applicants have not referred to any specifics in the art. Moreover, while Applicants acknowledge the teaching of the front tracking method in Karlsen, they have not made an actual argument. As explained in the rejection, Popinet as well as Karlsen teach iteratively changing the form of the interface until the pressures on either side of at least part of the interface become equal at any point of this part *(P: section 3 [front tracking algorithm]; section 3.1 (advecting]; section 3.3 [Redistribution]; section 3.6. [Pressure gradient correction]; K: "The two phase flow model" [pp. 5-7] including the pressure equation [pp. 6-7 and its development on pp. 7-13]; piece-wise numerical strategy [pp. 7-13]; piece-wise linear front tracking algorithm [pp. 22-24]; finite element implementations [pp. 24-26])*.

48. It is noted that "porous" is not recited in the claims. It is also noted that "for which the stationary displacements are *optimized*" is not defined and therefore depends upon intended use. Regardless, Karlsen, for example, teaches (pp. 5-6):

THE TWO-PHASE FLOW MODEL

We study immiscible flow of water and oil in a two-dimensional oil reservoir Ω over a time period $(0,T]$. To focus on the main ideas of the algorithm,

we consider a simplified prototype two-phase model[22], assume incompressible flow, and neglect gravity. If we choose the total Darcy velocity u, the global fluid pressure p, and the water saturation s as primary variables, the immiscible displacement of oil by water is governed by a (non-dimensional) system of nonlinear partial differential equations.

We have the pressure equation

$$-\nabla \cdot (K(\lambda_w + \lambda_o)\nabla p) = 0, \text{ in } \Omega \times (0,T], \quad (6)$$

where $K = K(x,y)$ denotes the absolute permeability tensor, $\lambda_i = k_{ri}/\mu_i$ are the mobilities, $k_{ri} = k_{ri}(s)$ the relative permeabilities, and μ_i the viscosities of water and oil, $i = w, o$, respectively.

The pressure equation is coupled via the total Darcy velocity $u = -K(\lambda_w + \lambda_o)\nabla p$ to the saturation equation

$$\phi\partial_t s + \nabla \cdot (uf) - \varepsilon\nabla \cdot (D\nabla s) = 0, \text{ in } \Omega \times (0,T]. \quad (7)$$

Here $\phi = \phi(x,y)$ is the porosity of the rock in the reservoir. The fractional

Conclusion

49. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

50. A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

51. Any inquiry concerning this communication or earlier communications from the examiner should be:

directed to: Dr. Hugh Jones telephone number (571) 272-3781,

Monday-Thursday 0830 to 0700 ET,

or

the examiner's supervisor, Kamini Shah, telephone number (571) 272-2279.
Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist, telephone number (703) 305-3900.

mailed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to:

(703) 308-9051 (for formal communications intended for entry)

or (703) 308-1396 (for informal or draft communications, please label *PROPOSED* or *DRAFT*).

Dr. Hugh Jones
Primary Patent Examiner
September 14, 2007

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